

Appl. No. 10/708,202  
Amdt. dated March 15, 2006  
Reply to Office action of February 21, 2006

**Pending Claims:**

This listing of claims represents the remaining claims 1-26 in this application:

**Listing of Claims:**

Claim 1 (Previously Presented): A variable gain amplifier, comprising:

- 5        an amplifying stage for generating an output voltage according to an input voltage; and  
      a variable gain stage coupled to the amplifying stage by using a current mirror structure  
      for adjusting a voltage gain of the amplifying stage according to at least a  
      controlling voltage;  
      wherein the denominator of the voltage gain is a simple exponential function, the  
10       voltage gain is decreasing while the controlling voltage is increasing, and the  
      controlling voltage is determined according to the subtraction between a first  
      controlling voltage and a second controlling voltage.

Claim 2 (Original): The variable gain amplifier of claim 1, wherein the simple exponential  
15       function comprises a function which raises a base to the power of an argument, without  
      an addition operation or a subtraction operation with a constant being performed on the  
      function.

Claim 3 (Previously Presented): The variable gain amplifier of claim 1, wherein the value  
20       of the simple exponential function is determined by the difference between the first and  
      the second controlling voltages.

Claim 4 (Original): The variable gain amplifier of claim 3, wherein the variable gain stage  
25       is a transconductance amplifier for generating a gain current according to the difference  
      between the first and the second controlling voltages.

Claim 5 (Original): The variable gain amplifier of claim 4, wherein the variable gain  
stage comprises:

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- a first transistor coupled to the first controlling voltage;  
a second transistor coupled to the second controlling voltage;  
a first current source coupled to the emitter of the first and the second transistors for  
providing a first current; and  
5 a second current source for generating the gain current, wherein the value of the gain  
current is determined by the first current and the difference between the first and  
the second controlling voltages.

- Claim 6 (Original): The variable gain amplifier of claim 5, wherein the variable gain  
10 stage further comprises:  
a first resistor coupled between the collector of the first transistor and the second current  
source; and  
a second resistor coupled between the collector of the second transistor and the second  
current source.

- 15 Claim 7 (Original): The variable gain amplifier of claim 5, wherein the amplifying stage  
comprises:  
an input unit coupled to the input voltage for generating an input current according to  
the input voltage;  
20 a current transforming unit for generating a second current according to the gain current;  
and  
a transresistance amplifying unit for generating the output voltage, wherein the value of  
the output voltage is determined by the input current and the second current.

- 25 Claim 8 (Original): The variable gain amplifier of claim 7, wherein the input unit comprises  
an input transistor coupled to the input voltage for generating the input current  
according to the input voltage.

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Claim 9 (Original): The variable gain amplifier of claim 7, wherein the current transforming unit comprises:

a third transistor, the collector of the third transistor being coupled to the base of the third transistor;

5 a fourth transistor;

a third current source coupled to the emitter of the third and the fourth transistors for providing a third current; and

a fourth current source for generating the second current;

10 whereby the ratio between the third current and the first current is substantially equivalent to the ratio between the second current and the gain current.

Claim 10 (Original): The variable gain amplifier of claim 9, wherein the current transforming unit further comprises:

15 a third resistor coupled between the collector of the third transistor and the fourth current source; and

a fourth resistor coupled between the collector of the fourth transistor and the fourth current source.

Claim 11 (Original): The variable gain amplifier of claim 9, wherein the transresistance amplifying unit comprises:

20 a fifth transistor, the base and the collector of the fifth transistor being coupled to the base of the fourth transistor;

a sixth transistor, the base of the sixth transistor being coupled to the base of the third transistor;

25 a seventh transistor, the base and the collector of the seventh transistor being coupled to the emitter of the fifth and the sixth transistors;

a fifth current source coupled to the input unit and the collector of the fifth transistor for providing a fifth current; and

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an output resistor coupled to the collector of the sixth transistor for generating the output voltage.

5      Claim 12 (Previously Presented): The variable gain amplifier of claim 3, wherein the voltage gain is expressed as  $C1/\exp(C2(V1-V2)/Vt)$ , wherein both C1 and C2 are constant values, V1 is the first controlling voltage, Vt is the thermal voltage, and V2 is the second controlling voltage.

10      Claim 13 (Original): The variable gain amplifier of claim 1, wherein the variable gain amplifier is the half-circuit of a differential amplifier.

15      Claim 14 (Previously Presented): A variable gain amplifier, comprising:  
an amplifying stage for generating an output voltage according to an input voltage;  
and  
a variable gain stage coupled to the amplifying stage by using a current mirror  
structure for adjusting a voltage gain of the amplifying stage according to at least  
a controlling voltage;  
wherein the voltage gain increases linearly in decibel while the controlling voltage  
decreases and the controlling voltage is determined by the subtraction between a  
20      first controlling voltage and a second controlling voltage.

25      Claim 15 (Previously Presented): The variable gain amplifier of claim 14, wherein the voltage gain changes linearly in decibel with respect to a simple exponential function, and the value of the simple exponential function is determined by the controlling voltage.

Claim 16 (Previously Presented): The variable gain amplifier of claim 15, wherein the simple exponential function comprises a function which raises a base to the power

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of an argument, without an addition operation or a subtraction operation with a constant being performed on the function.

5 Claim 17 (Previously Presented): The variable gain amplifier of claim 14, wherein the voltage gain changes linearly in decibel according to the difference between the first and the second controlling voltages.

10 Claim 18 (Previously Presented): The variable gain amplifier of claim 17, wherein the variable gain stage is a transconductance amplifier for generating a gain current according to the difference between the first and the second controlling voltages.

Claim 19 (Previously Presented): The variable gain amplifier of claim 18, wherein the variable gain stage comprises:  
a first transistor coupled to the first controlling voltage;  
15 a second transistor coupled to the second controlling voltage;  
a first current source coupled to the emitter of the first and the second transistors for providing a first current; and  
a second current source for generating the gain current, wherein the value of the gain current is determined by the first current and the difference between the first and the  
20 second controlling voltages.

Claim 20 (Previously Presented): The variable gain amplifier of claim 19, wherein the variable gain stage further comprises:  
a first resistor coupled between the collector of the first transistor and the second  
25 current source; and  
a second resistor coupled between the collector of the second transistor and the second current source.

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Claim 21 (Previously Presented): The variable gain amplifier of claim 18, wherein the amplifying stage comprises:

an input unit coupled to the input voltage for generating an input current according to the input voltage;

5 a current transforming unit for generating a second current according to the gain current; and

a transresistance amplifying unit for generating the output voltage, wherein the value of the output voltage is determined by the input current and the second current.

10 Claim 22 (Previously Presented): The variable gain amplifier of claim 21, wherein the input unit comprises an input transistor coupled to the input voltage for generating the input current according to the input voltage.

15 Claim 23 (Previously Presented): The variable gain amplifier of claim 21, wherein the current transforming unit comprises:

a third transistor, the collector of the third transistor being coupled to the base of the third transistor;

a fourth transistor;

20 a third current source coupled to the emitter of the third and the fourth transistors for providing a third current; and

a fourth current source for generating the second current;

whereby the ratio between the third current and the first current is substantially equivalent to the ratio between the second current and the gain current.

25 Claim 24 (Previously Presented): The variable gain amplifier of claim 23, wherein the current transforming unit further comprises:

a third resistor coupled between the collector of the third transistor and the fourth current source; and

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a fourth resistor coupled between the collector of the fourth transistor and the fourth current source.

Claim 25 (Previously Presented): The variable gain amplifier of claim 23, wherein the  
5 transresistance amplifying unit comprises:

a fifth transistor, the base and the collector of the fifth transistor being coupled to the base of the fourth transistor;

a sixth transistor, the base of the sixth transistor being coupled to the base of the third transistor;

10 a seventh transistor, the base and the collector of the seventh transistor being coupled to the emitter of the fifth and the sixth transistors;

a fifth current source coupled to the input unit and the collector of the fifth transistor for providing a fifth current; and

15 an output resistor coupled to the collector of the sixth transistor for generating the output voltage.

Claim 26 (Previously Presented): The variable gain amplifier of claim 17, wherein the voltage gain is expressed as  $C1/\exp(C2(V1-V2)/Vt)$ , wherein both  $C1$  and  $C2$  are constant values,  $V1$  is the first controlling voltage,  $Vt$  is the thermal voltage, and  $V2$   
20 is the second controlling voltage.

Claim 27. (Cancelled)

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